

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/41

Paper 4 Mechanics 1 (**M1**)

October/November 2019

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value for the acceleration due to gravity is needed, use 10 m s^{-2} .

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 50.

This document consists of **14** printed pages and **2** blank pages.



- 1 A crane is lifting a load of 1250 kg vertically at a constant speed $V \text{ m s}^{-1}$. Given that the power of the crane is a constant 20 kW, find the value of V . [2]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 2 The total mass of a cyclist and her bicycle is 75 kg. The cyclist ascends a straight hill of length 0.7 km inclined at 1.5° to the horizontal. Her speed at the bottom of the hill is 10 m s^{-1} and at the top it is 5 m s^{-1} . There is a resistance to motion, and the work done against this resistance as the cyclist ascends the hill is 2000 J. The cyclist exerts a constant force of magnitude $F \text{ N}$ in the direction of motion. Find F . [5]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 3 A block of mass 3 kg is at rest on a rough plane inclined at 60° to the horizontal. A force of magnitude 15 N acting up a line of greatest slope of the plane is just sufficient to prevent the block from sliding down the plane.

(i) Find the coefficient of friction between the block and the plane.

[5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The force of magnitude 15 N is now replaced by a force of magnitude X N acting up the line of greatest slope.

- (ii) Find the greatest value of X for which the block does not move. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

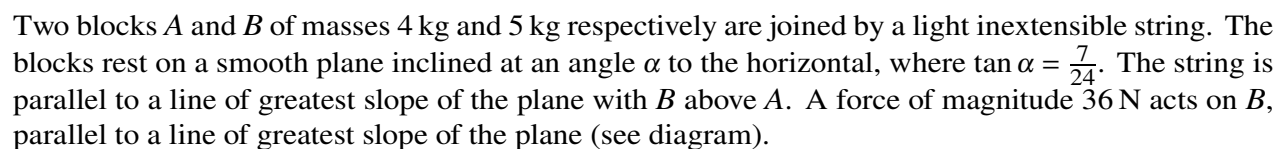
.....

.....

.....

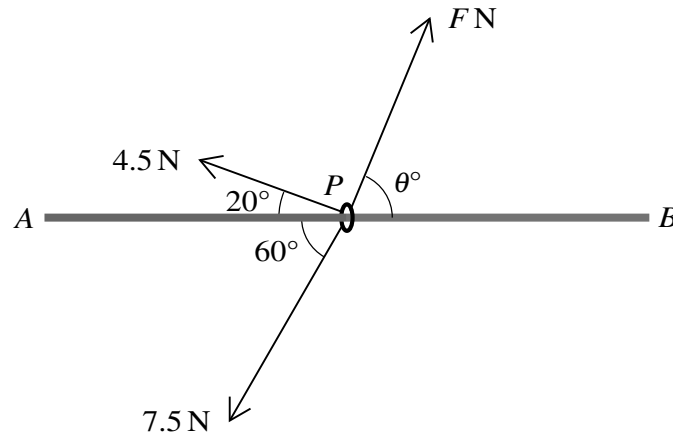
.....

.....



- [illegible]

- (ii) At a particular instant, the speed of the blocks is 1 m s^{-1} . Find the time, after this instant, that it takes for the blocks to travel 0.65 m. [2]



A small ring P is threaded on a fixed smooth horizontal rod AB . Three horizontal forces of magnitudes 4.5 N , 7.5 N and $F\text{ N}$ act on P (see diagram).

- (i) Given that these three forces are in equilibrium, find the values of F and θ . [6]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (ii) It is given instead that the values of F and θ are 9.5 and 30 respectively, and the acceleration of the ring is 1.5 m s^{-2} . Find the mass of the ring. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 6 A particle of mass 0.4 kg is released from rest at a height of 1.8 m above the surface of the water in a tank. There is no instantaneous change of speed when the particle enters the water. The water exerts an upward force of 5.6 N on the particle when it is in the water.

(i) Find the velocity of the particle at the instant when it reaches the surface of the water. [2]

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Find the time that it takes from the instant when the particle enters the water until it comes to instantaneous rest in the water. You may assume that the tank is deep enough so that the particle does not reach the bottom of the tank. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (iii) Sketch a velocity-time graph for the motion of the particle from the instant at which it is released until it comes to instantaneous rest in the water. [3]

- 7** A particle moves in a straight line, starting from rest at a point O , and comes to instantaneous rest at a point P . The velocity of the particle at time t s after leaving O is v m s⁻¹, where

$$v = 0.6t^2 - 0.12t^3.$$

- (i) Show that the distance OP is 6.25 m. [5]

[illegible]

It is given that the particle passes point P with velocity 1.25 m s^{-1} at time $t = 5$.

- [illegible]

-
-
-
-

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/42

Paper 4 Mechanics 1 (M1)

October/November 2019

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value for the acceleration due to gravity is needed, use 10 m s^{-2} .

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

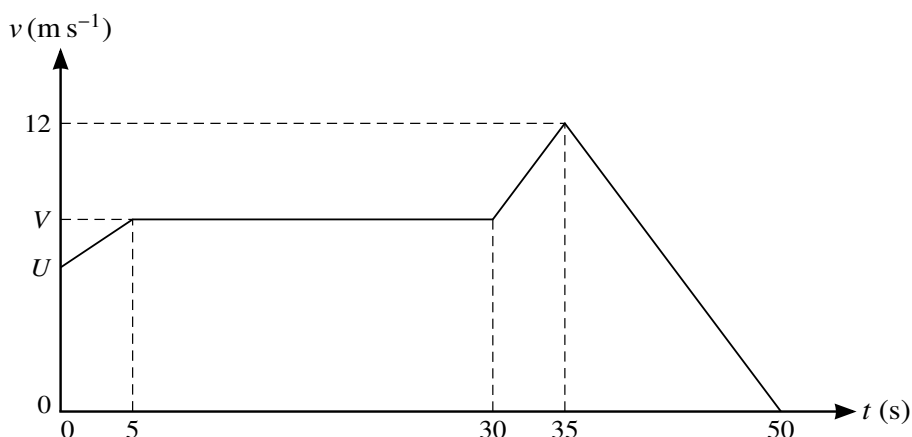
The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 50.

This document consists of **13** printed pages and **3** blank pages.



2



The diagram shows a velocity-time graph which models the motion of a tractor. The graph consists of four straight line segments. The tractor passes a point O at time $t = 0$ with speed $U \text{ m s}^{-1}$. The tractor accelerates to a speed of $V \text{ m s}^{-1}$ over a period of 5 s, and then travels at this speed for a further 25 s. The tractor then accelerates to a speed of 12 m s^{-1} over a period of 5 s. The tractor then decelerates to rest over a period of 15 s.

- (i) Given that the acceleration of the tractor between $t = 30$ and $t = 35$ is 0.8 m s^{-2} , find the value of V . [2]

.....

.....

.....

.....

.....

- (ii) Given also that the total distance covered by the tractor in the 50 seconds of motion is 375 m, find the value of U . [3]

.....

.....

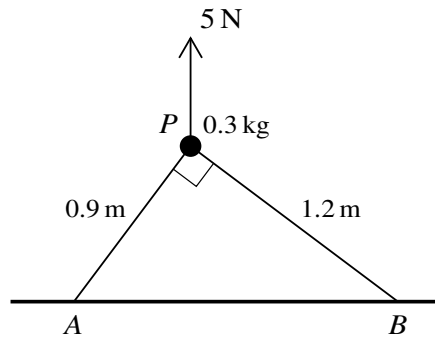
.....

.....

.....

.....

.....



A particle P of mass 0.3 kg is held in equilibrium above a horizontal plane by a force of magnitude 5 N , acting vertically upwards. The particle is attached to two strings PA and PB of lengths 0.9 m and 1.2 m respectively. The points A and B lie on the plane and angle $APB = 90^\circ$ (see diagram). Find the tension in each of the strings. [5]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 4 A lorry of mass 25 000 kg travels along a straight horizontal road. There is a constant force of 3000 N resisting the motion.

(i) Find the power required to maintain a constant speed of 30 m s^{-1} . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The lorry comes to a straight hill inclined at 2° to the horizontal. The driver switches off the engine of the lorry at the point *A* which is at the foot of the hill. Point *B* is further up the hill. The speeds of the lorry at *A* and *B* are 30 m s^{-1} and 25 m s^{-1} respectively. The resistance force is still 3000 N.

(ii) Use an energy method to find the height of *B* above the level of *A*. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 5 Two particles A and B move in the same vertical line. Particle A is projected vertically upwards from the ground with speed 20 m s^{-1} . One second later particle B is dropped from rest from a height of 40 m .

(i) Find the height above the ground at which the two particles collide. [4]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, providing a template for handwriting practice or general writing. There are no margins, text, or other markings on the page.

[illegible]

- 6** A block of mass 3 kg is initially at rest on a rough horizontal plane. A force of magnitude 6 N is applied to the block at an angle of θ above the horizontal, where $\cos \theta = \frac{24}{25}$. The force is applied for a period of 5 s, during which time the block moves a distance of 4.5 m.

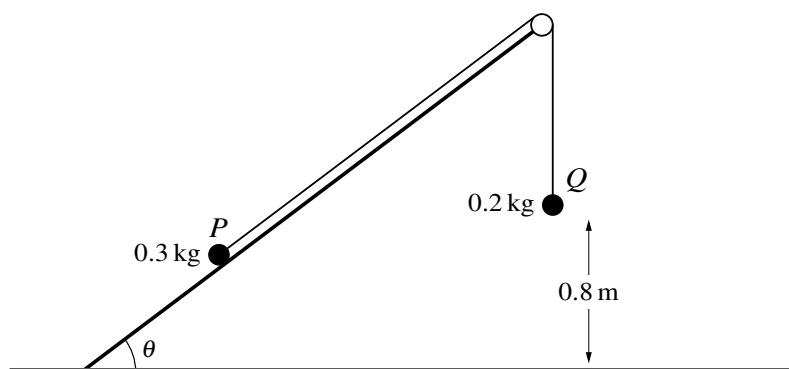
(i) Find the magnitude of the frictional force on the block.

[4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(ii) Show that the coefficient of friction between the block and the plane is 0.165, correct to 3 significant figures. [3]

- [illegible]



Two particles P and Q , of masses 0.3 kg and 0.2 kg respectively, are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley which is attached to the edge of a smooth plane. The plane is inclined at an angle θ to the horizontal, where $\sin \theta = \frac{3}{5}$. P lies on the plane and Q hangs vertically below the pulley at a height of 0.8 m above the floor (see diagram). The string between P and the pulley is parallel to a line of greatest slope of the plane. P is released from rest and Q moves vertically downwards.

- (i) Find the tension in the string and the magnitude of the acceleration of the particles. [5]

This image shows a full page of a worksheet designed for handwriting practice. It features ten sets of horizontal dashed lines spaced evenly down the page. Each set consists of two short dashes followed by a longer dash, creating a guide for letter height and placement. The background is plain white, and there are no margins or additional markings.

Q hits the floor and does not bounce. It is given that P does not reach the pulley in the subsequent motion.

- (ii) Find the time, from the instant at which P is released, for Q to reach the floor. [2]

.....

.....

.....

.....

.....

.....

- (iii) When Q hits the floor the string becomes slack. Find the time, from the instant at which P is released, for the string to become taut again. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[illegible]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/43

Paper 4 Mechanics 1 **(M1)**

October/November 2019

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value for the acceleration due to gravity is needed, use 10 m s^{-2} .

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 50.

This document consists of **13** printed pages and **3** blank pages.



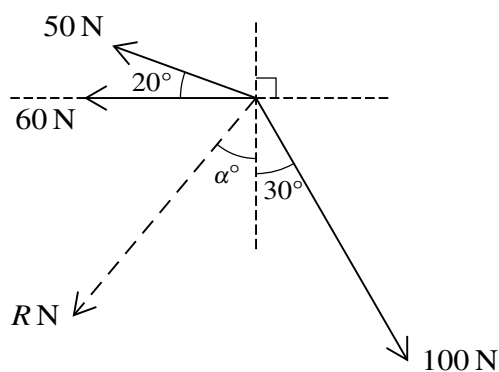
BLANK PAGE

- 1 A crate of mass 500 kg is being pulled along rough horizontal ground by a horizontal rope attached to a winch. The winch produces a constant pulling force of 2500 N and the crate is moving at constant speed. Find the coefficient of friction between the crate and the ground. [3]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

- 2 A train of mass 150 000 kg ascends a straight slope inclined at α° to the horizontal with a constant driving force of 16 000 N. At a point A on the slope the speed of the train is 45 m s^{-1} . Point B on the slope is 500 m beyond A . At B the speed of the train is 42 m s^{-1} . There is a resistance force acting on the train and the train does $4 \times 10^6 \text{ J}$ of work against this resistance force between A and B . Find the value of α . [5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings on the page.



Three coplanar forces of magnitudes 50 N, 60 N and 100 N act at a point. The resultant of the forces has magnitude R N. The directions of these forces are shown in the diagram. Find the values of R and α . [6]

[illegible]

- 4 A car travels along a straight road with constant acceleration. It passes through points P , Q , R and S . The times taken for the car to travel from P to Q , Q to R and R to S are each equal to 10 s. The distance QR is 1.5 times the distance PQ . At point Q the speed of the car is 20 m s^{-1} .

(i) Show that the acceleration of the car is 0.8 m s^{-2} . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

© UCLES 2019

- 5 A cyclist is travelling along a straight horizontal road. The total mass of the cyclist and his bicycle is 80 kg. His power output is a constant 240 W. His acceleration when he is travelling at 6 m s^{-1} is 0.3 m s^{-2} .

(i) Show that the resistance to the cyclist's motion is 16 N. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Find the steady speed that the cyclist can maintain if his power output and the resistance force are both unchanged. [2]

.....

.....

.....

.....

.....

.....

This image shows a full page of a document template. It consists of approximately 28 evenly spaced horizontal dotted lines across the entire width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings present.

- 6 Particle P travels in a straight line from A to B . The velocity of P at time t s after leaving A is denoted by $v \text{ m s}^{-1}$, where

$$v = 0.04t^3 + ct^2 + kt.$$

P takes 5 s to travel from A to B and it reaches B with speed 10 m s^{-1} . The distance AB is 25 m.

- (i) Find the values of the constants c and k .

[6]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

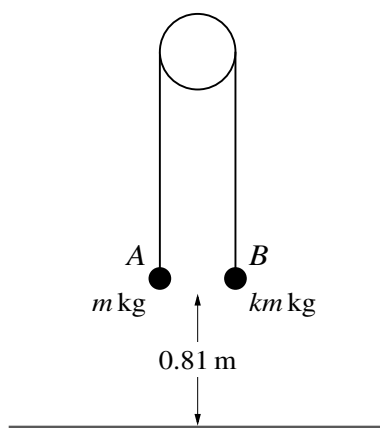
.....

.....

.....

(ii) Show that the acceleration of P is a minimum when $t = 2.5$.

[3]



Two particles A and B have masses m kg and km kg respectively, where $k > 1$. The particles are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley and the particles hang vertically below it. Both particles are at a height of 0.81 m above horizontal ground (see diagram). The system is released from rest and particle B reaches the ground 0.9 s later. The particle A does not reach the pulley in its subsequent motion.

- (i) Find the value of k and show that the tension in the string before B reaches the ground is equal to $12m\text{ N}$. [7]

[illegible]

At the instant when B reaches the ground, the string breaks.

- (ii) Show that the speed of A when it reaches the ground is 5.97 m s^{-1} , correct to 3 significant figures, and find the time taken, after the string breaks, for A to reach the ground. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (iii) Sketch a velocity-time graph for the motion of particle A from the instant when the system is released until A reaches the ground. [2]

[illegible]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.